

P-3.3 Explain, both conceptually and quantitatively, how energy can transfer from one system to another (including work, power, and efficiency).

Revised Taxonomy Levels 2.7 B Explain conceptual knowledge

Key Concepts

Work

Power

Efficiency

This concept is not addressed in physical science

It is essential for all students to

Apply and analyze the relationships among energy, work, power, and efficiency both conceptually and quantitatively in linear and rotational systems

❖ Understand that power is the rate of work, power = work/time

❖ Understand that the unit for linear power is the watt,

joule/sec

(Newton)(meter)/sec

	Linear Motion	Rotary Motion
	Force (F)	Torque (τ)
kinetic energy	$E_k = \frac{1}{2} mv^2$	$E_k = \frac{1}{2} m \omega^2$
work	$W = F\Delta d$	$W = \tau \Delta \theta$
Power	$P = W/t$ $P = F\Delta d/t$	$P = W/t$ $P = \tau \Delta \theta/t$
Efficiency	Efficiency = $W_{\text{output}}/W_{\text{input}}$	Efficiency = $W_{\text{output}}/W_{\text{input}}$

- ❖ Compare ideal and actual force transformers
- ❖ Apply force transformation formulas to calculate efficiency of rotational systems
- ❖ Explain how a wheel and axel transforms force
- ❖ Explain how belt-drivers, gear-drives and disk-drives use similar methods to achrive trade-offs between torque and speed

Assessment

The verb explain means that the major focus of assessment should be for students to “construct a cause and effect model”. In this case, assessments will ensure that students can model how the energy is conserved during transformations in terms of work, energy, power and efficiency.

Because the indicator is written as conceptual knowledge, assessments should require that students understand the “interrelationships among the basic elements within a larger structure that enable them to function together.” In this case, assessments must show that students can construct a cause and effect statement relating how a each variable (work, energy, power, and efficiency) are involved in specific energy transformations.

